Application Brief

Extending PLC and PAC Processor GPIO With Agile I2C I/O Expansion

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Modern Programmable Logic Controller (PLC) and Programmable Automation Controller (PAC) systems (see Figure 1) continue to evolve with each new product generation, incorporating increasingly advanced features and capabilities. To stay competitive, manufacturers often introduce new functionalities that expand use cases and attract customers.

For PLC system designers, integrating additional features presents significant challenges, particularly in optimizing the performance of microprocessors, microcontrollers, and FPGAs within these systems. The primary processor in a PLC plays a crucial role and typically represents a substantial portion of the IC bill of materials. As a result, designers strive to maximize its efficiency rather than resorting to more powerful and expensive alternatives. The processor in the system is responsible for coordinating and interfacing with various peripheral components and subsystems, including sensors, wired and wireless communication modules, other processors, and additional peripheral circuits. These interactions are essential to delivering the core functionality (see Figure 1).

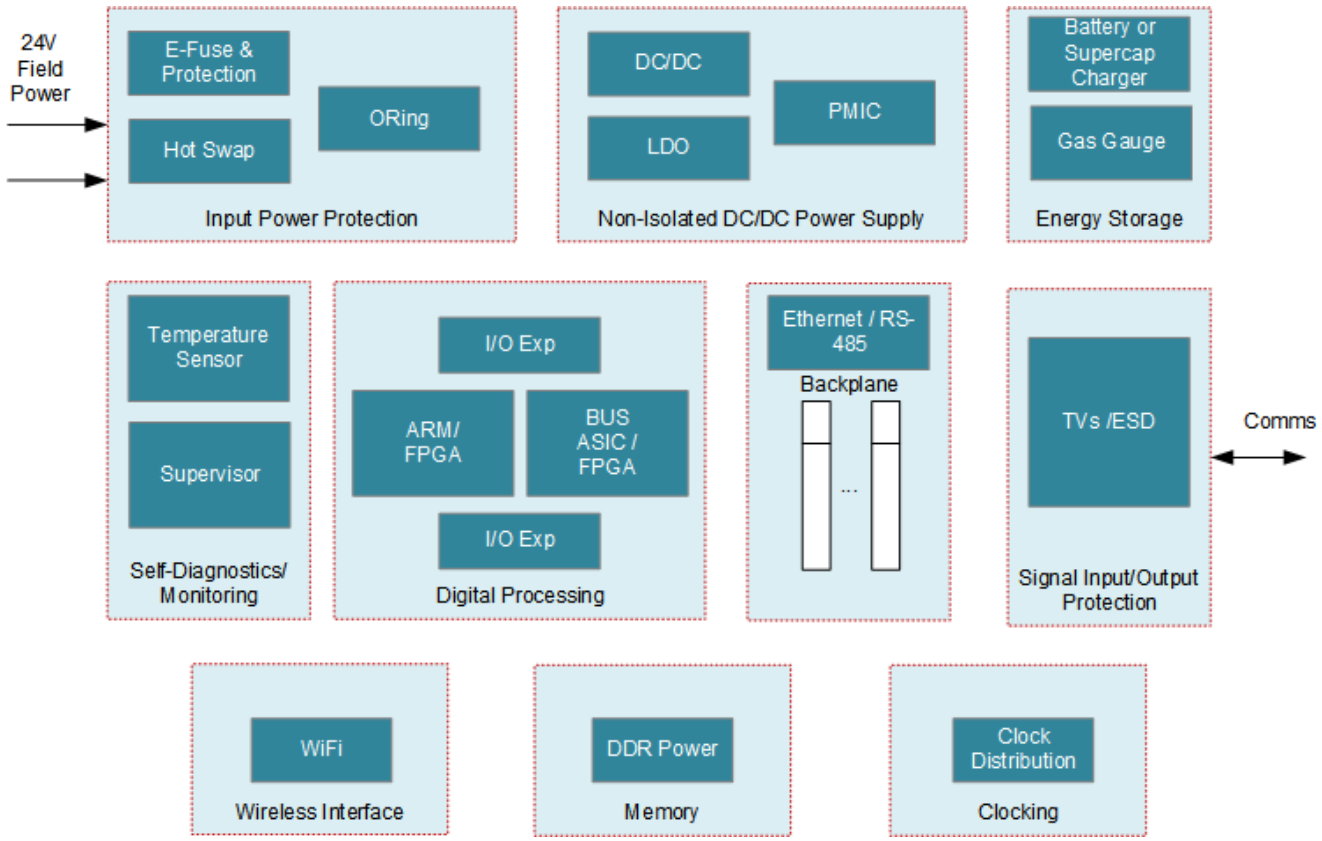

Figure 1. PLC Block Diagram

Given the importance of processors having enough of the correct type of input/output (I/O) resources to implement the processor to peripheral circuit connectivity needed for a specific system design, systems designers need to select processors with the appropriate number of I/O as well as to make sure the I/O has the needed capabilities. Systems designers have used I/O expander circuits to supplement their processors I/O resources rather than moving to a new processor with more I/O given that moving to a larger processor can increase system cost and complexity. I/O expanders have been available for some time and one of the most popular types of I/O expanders are I2C I/O expanders as these devices enable system designers to control a larger number of GPIO with a single I2C interface connection.

New system designs are now requiring even more capability and flexibility from their processor I/O. To accommodate modern system design needs of greater processor I/O resource flexibility, system designers can now leverage TI's new TCAL family of I2C I/O expanders with Agile I/O capabilities. The new TCAL family provides system designers I2C I/O expansion that they are likely very familiar with but with the added benefit of programmable I/O functionality that extends the I/O capabilities beyond traditional I2C I/O expansion. Agile I/O provides for added capabilities such as programmable output drive strength, latchable inputs, maskable interrupts, interrupt status registers, programmable output configuration, and selectable pull-up/pull down resistor values. Agile I/O functionality provides system designers with unique benefits (see Table 1) that enables systems designers to use I/O resource for a wider range of use cases.

Table 1. Agile I/O Benefits

Agile I/O Feature	Benefit
Programmable output drive strength	• Helps conserve battery power • Reduces EMI issues and system noise
Latchable inputs	• Locks in any changes on input pins until the input port register is read eliminates external hardware • Simplifies software
Mask Interrupt	• Selects which inputs can cause an interrupt event on the output pin simplifying Interrupt service software • Masks abnormal interrupts from meddling with software performance
Interrupt status register	• Simplifies interrupt service routine software by specifying which input caused an event on the pin • Improves software performance
Programmable output configuration	• Customizable output configurations (open-drain or push-pull outputs) • Increases flexibility and simplifies software
Selectable input pull-up/pull down register	Reduces BOM cost by eliminating need for external resistors

For example, a single TCAL I/O expander can support I/O connectivity with peripheral devices requiring open drain I/O and well as peripherals that require push-pull I/O (Figure 2 and Figure 3). In addition, agile I/O capabilities like latchable inputs, maskable Interrupts and interrupt status registers, simplify software development efforts associated with servicing interrupts compared to traditional I2C I/O expanders.

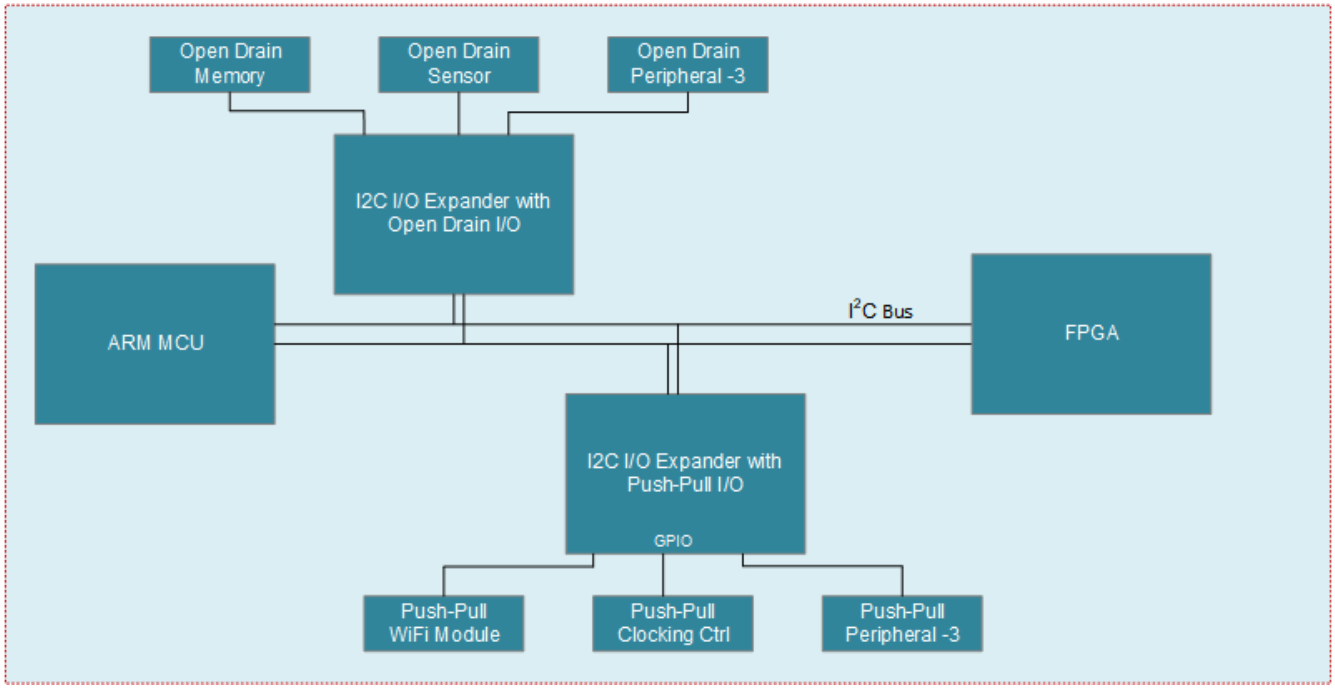

Figure 2. Multiple I2C I/O Expanders Supporting open Drain and Push Pull I/O

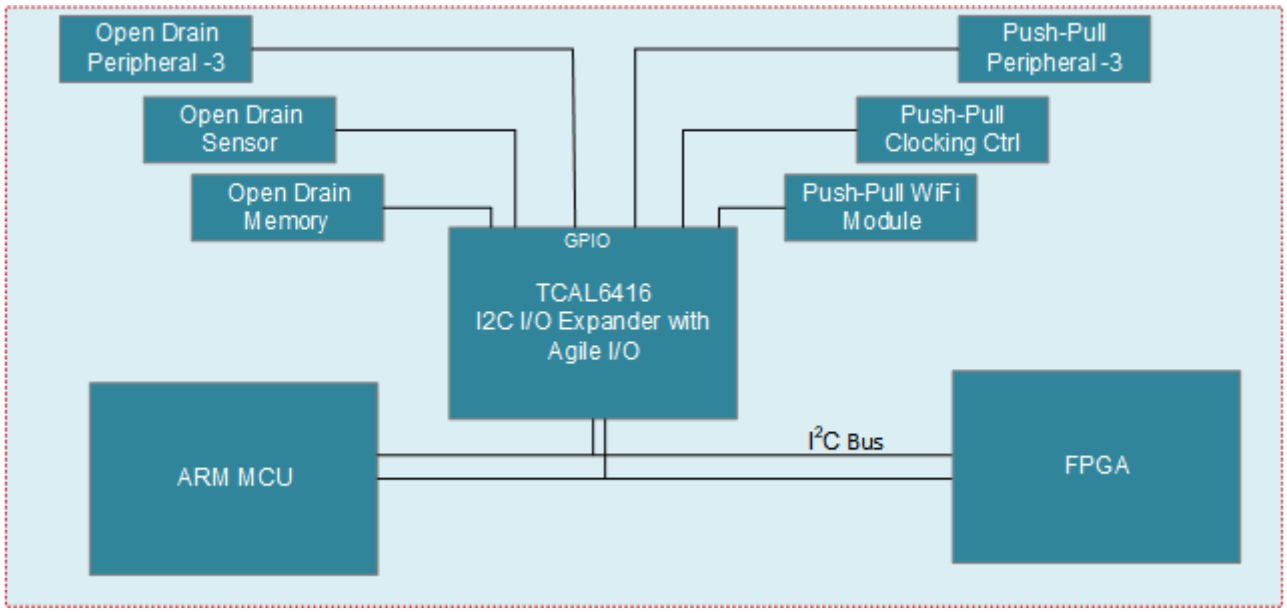

Figure 3. One I2C I/O Expander Device Supporting Open Drain and Push-Pull I/O

Next generation I2C I/O expanders such as TI's new TCAL6xxx dual supply and TCAL9xxx single supply I2C I/O expanders with agile I/O provide systems designers flexible I2C I/O expansion capabilities helping to maximize the utility of their processor selection while simplifying firmware implementation. For more information on TI's TCAL I2C I/O expansion device please visit TI's I2C I/O expansion landing page.

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